the cores compared to the rims (XMg = 0.8). Pargasitic amphibole shows three zones that gradually change from dark core to rim. The dark-green cores have higher XMg (0.83) and Altot (2.221 a.f.u.) then the light-green rims (XMg = 0.6 – 0.7, Alt = 2.111 a.f.u.).

Back-scattered electron images of garnet allowed identification of two garnet generations (Grt I and Grt II).The older garnet (Grt I) has high Mg contents (Py13–15, Alm53–55, Grs29–30). Some large porphyroblasts of this garnet have dark-gray domains with slightly lower Fe (Alm48–50) and higher Ca (Grs31–34). By contrast, the younger garnet (Grt II), which rims or forms veinlets in Grt I, has high Ca and low Mg (Grs40–45, Py0.2–0.5, Alm46–51). Textural relations and mineral composition in combination with available geochronological dating, indicate multi-stage igneous and metamorphic origin of minerals in the studied metabasite. (1) Magmatic stage is characterized by relicts of clinopyroxene in amphibolite. (2) First (Variscan) metamorphism is represented by older amphibole (amph1) and garnet (Grt I) and reequilbrated parts of clinopyroxene. Temperature of 713 ± 7 °C was calculated for this metamorphism. Pressure estimated only from Al content in amphibole and high Ca and Mg content in garnet were > 7 kbar. Chemical zoning in garnet and amphibole indicate retrograde P-T path for this metamorphism. (3) A new metamorphic event is manifested in the formation of Ca-rich and Mg-poor garnet (Grt II) which appears to be in textural equilibrium with amph2, epidote and chlorite. Pressure and temperature of 550 °C and 10.2 kbar were calculated for this metamorphism.

Fracturing and formation of veinlets in garnet were probably imposed by volume increase during retrogression along an exhumation path where temperature decreased. In the situation where retrogression is driven by hydration reactions, strong gradients in fluid composition may occur. The new garnet derived by dehydration reactions of hydrous phases that had been already formed during retrogression from amphibolite facies metamorphism. Mass balance calculations on Si, Al, Mg+Fetot, Ca and H_2O indicate formation of the garnet from epidote and chlorite. However more Fe-rich chlorite and epidote are needed to balance Fetot and Mg contents.

To analyse diffusion exchange between older and younger (rim and veinlet) garnet, concentration profiles across interfaces of these garnet varieties were measured by microprobe beam at 2 µm steps. Very sharp contact between these two garnets with contrasting composition provides the opportunity to put constraints on the duration and rate of uplift. Modelling the observed diffusion profiles gave a time span of about 2×10^5 years for cooling of garnet Grt II from 550 to 450 °C along the uplift path from 10 to 4 kbar.

Layered Metaigneous Complex of the Veporic Basement with Features of the Variscan and Alpine Metamorphism (the Western Carpathians, Slovak Republic).

Ivana FILOVÁ[1], Ján MADARÁS[1] and Marián PUTIŠ[2]

[1] *Dionýz Štúr Geological Institute, Mlynská dolina 1, 817 04 Bratislava, Slovak Republic*
[2] *Department of Petrology and Mineralogy, Faculty of Natural Sciences, Comenius University, Mlynská dolina G, 842 15 Bratislava, Slovak Republic*

Geological setting

The Veporicum is an internal part of the central domain of the Western Carpathians and it is an area consisting of several tectonically approached units with different age. The layered metaigneous complex (LMC) is a part of the Veporic basement of the Central Western Carpathians. This complex is regionally widespread in the northwestern part of the Slovenské Rudohorie Mts. and the eastern part of the Nízke Tatry Mts. The studied basement complex was originally termed as the gabbro-peridotite-basalt formation (Miko and Putiš, 1989 in Krist et al., 1992) in the area of the eastern Low Tatra Mts. It was included into the leptynite-amphibolite complex (LAC, Hovorka and Méres, 1993). The layered metamagmatic-amphibolitic rocks are part of the pre-Alpine Čierny Balog (CB) supracrustal complex. The CB complex is mainly represented by Ky-Grt gneisses, migmatitic gneisses and common to partially melted amphibolites.

Lithological composition of the layered metaigneous complex

Layered metaigneous complex is mainly represented by porphyric Qtz meta-diorites, which were dated approximatelly at 346 Ma, U – Pb on Zr. Layered metadiorites, in form of layered (banded) amphibolites, appear to be an inseparable part of metadiorites. Thus, at least a part of layered amphibolites appear to have magmatic origin in dioritic protoliths. Strongly layered parts of metadioritic body contain rare 2–3 dm fragments of metagabbros (Amph – Px + Pl). Amph-rich layers of metadioritic composition, or pale tonalitic to trondhemitic layers are also present within the metadioritic bodies less than 100 m thick. Undifferentiated dioritic parts have composition which is an average of the dark (Amph, Pl, Ttn, + Qtz) and pale (Pl, QTz, Mgt, + Amph, + Bt) bands. A special lithological member appears to be layered amphibolite (resembling leptynite-amphibolites, e.g., Neubauer, 1989; Hovorka et al., 1992; Putiš, 1992) thus representing a characteristic pre-Alpine lithological feature of the layered mataigneous complex.

The most likely mechanism of the relic magmatic layering appears to be magmatic laminar flow, accompanying differentiation and alignment of Pl and Am mega- and microcrysts parallel to the direction of flow, e.g., in porphyric (meta)diorites (e.g., Parsons, 1987; Fountain et al., eds. 1992; Percival et al., 1992; Shelley, 1992; Hall, 1996). The development of layering was influenced by the extensional emplacement conditions of the magmatic sills into the shear zone accompanying an extensional detachment fault. Thus a continuous evolution of the magmatic to subsolidus and solidus foliation might have formed (e.g., Patterson et al., 1989, 1990; Shelley, 1992). The mentioned conditions might have caused the thinning of already magmatically differentiated and mixed sills, controlled by propagation (opening) of an extensional shear zone. All lithological members were thinned and stretched into straight bands with sharp boundaries, changing the mineral grain size, due to superimposed strong ductile deformation and recrystallization at medium-T conditions within a deep-crustal shear zone.

Deformation-recrystallization stages

It is possible to distinguish the next deformation-recrystallization stages in the main types of rocks:

1. Metadiorites to metagabbrodiorites
   DR1 (prograde burial, Variscan): Am1 (Mg Hbl, edenite pargasite?), Pl, Qtz, Ep-Czo, Grt, Bt1, ±Ttn
   DR2-1 (extensional exhumation, Variscan): Am2 (Ts), Pl, Grt
   DR2-2 (late Variscan? or Alpine cooling): Am2 (Act), Ab, Chl2, Bt2, Ms-Phe, ±Cld, Grs
2. layered metadiorites amphibolites (magmatic, subsolidus and solidus layering)
   DR1 (prograde, Variscan): Am1 (Mg-Hbl), Chl1, Qtz, Pl, Bt1
   Moreover, Px diopside of metahornblenditic lenses is replaced by Mg-Hbl(1).
   DR2-1 (extensional exhumation, Variscan): Am2 (Ts), Grt, Czo, Phe
   DR2-2 (late Variscan? or Alpine cooling): Am2 (Act), Ab, Ms, Bt2, Chl2, Grs, ±Cld

References

FOUNTAIN D.M., ARCULUS R., and KAY R. W., 1992. Continental Lower Crust. Elsevier, Amsterdam.

HALL A., 1996. Igneous Petrology. Longman Group Limited, Essex.

HOVORKA D., MÉRES Š. and IVAN P., 1992. Pre-Alpine Western Carpathians Mts. Basement complexes: Geochemistry, petrology, geodynamic setting. *Terra Nova abstr. Suppl.*, 4, 2: 32.

HOVORKA D. and MÉRES Š., 1993. Leptyno-amphibolite complex of the Western Carpathians: occurrences and lithology. *Mineralia Slov.*, 25: 1-9.

KRIST E., KORIKOVSKY S.P., PUTIŠ M., JANÁK M. and FARYAD S.W., 1992. Geology and petrology of metamorphic rocks of the Western Carpathian crystalline complexes. Com. Univ. Press, Bratislava.

NEUBAUER F., 1989. The “Leptinite-amphibolite complexes“ – a key for correlation of mid-European Variscides? In: R.D. DALLMEYER, Tectonostratigraphic expression of terrane accretion in the circum-Atlantic Paleozoic orogens. Abstracts, Athens, Georgia, U.S.A.

PARSONS I., 1987. Origin of Igneous Layering. Reidel, Dordrecht.

PATTERSON S.R., VERNON R.H. and TOBISCH O.T., 1989. A review of criteria for identification of magmatic and tectonic foliations in granitoids. *J. Struct. Geol.*, 11(3): 349-363.

PATERSON S.R., TOBISCH O.T. and MORAND V.J., 1990. The influence of large ductile shear zones on the emlacement and deformation of the Wyangala Batholith, SE Australia. *J. Struct. Geol.*, 12(5-6): 639-650.

PERCIVAL J.A., FOUNTAIN D.M., and SALISBURY M.H., 1992. Exposed crustal cross sections as windows on the lower crust. In: D.M. FOUNTAIN, R. ARCULUS and R.W. KAY, Continental Lower Crust. Elsevier, Amsterdam.

PUTIŠ M., 1992. Variscan and Alpidic nappe structures of the Western Carpathians crystalline basement. *Geol. Carpath.*, 43(6): 369-380.

SHELLEY D., 1992. Igneous and metamorphic rocks under the microscope. Chapman and Hall, London.

Lithological and Sedimentological Evolution of the Cambrian in the Měnín – 1 Borehole

Helena GILÍKOVÁ[1], Jaromír LEICHMANN[2], Radek MIKULÁŠ[3] and Slavomír NEHYBA[2]

[1] Czech Geological Survey, Leitnerova 22, 658 69 Brno, Czech Republic
[2] Department of Geology and Paleontology, Faculty of Science, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic
[3] Institute of Geology, Academy of Sciences, Rozvojová 135, 165 02 Praha 6, Czech Republic

The Lower Paleozoic clastic sediments (so-called “old red formation”) are assumed to be the oldest sedimentary formation overlaying the Precambrian Brunovistulian unit. These sediments have been originally described by the number of authors as “basal Devonian clastics” (Dvořák, 1998; Skoček, 1980 etc.). More recently, Lower Cambrian sediments were found in the boreholes Měnín 1 and Němčičky 3, Němčičky 6 (Jachowicz and Přichystal, 1997).

The Měnín borehole is situated 20 km to the south-east of Brno. The borehole is 2100m deep, the crystalline basement has not been reach. The Lower Cambrian microfossils of Acritarcha genus were identified at depth of 475–477,5 m (Jachowicz and Přichystal, 1997; Fatka et al., 1998). The sediments below the horizon with Acritarcha are considered to be of Cambrian age.

Petrological character of the studied sediments is monotonous. To the depth of 900 m grey to greenish grey fine to coarse-grained well-sorted quartzitic sandstones prevail over red to violet coloured arcosic sandstones. Below the 900 m red to violet coarse to fine-grained arcoses, greywacke sandstones with variable amounts of finer grained members were penetrated by the borehole Měnín. Three types of quartz, zoned K-feldspar, plagioclase, muscovite and biotite were observed in CL microscope. Zircon, tourmaline and apatite are common accessories. The rare cement is composed of recrystallized kaolinite or carbonate. The mineral composition of sediments and internal fab-